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मात्राएँ और इकाइयाँ

भाग 1 अन्तराल और समय

(तीसरा पुनरीक्षण)

Indian Standard

QUANTITIES AND UNITS

PART 1 SPACE AND TIME

(Third Revision)

UDC 53·081 : 531·111

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

June 1995 **Price Group 6**

Basic Standards Sectional Committee, MSD 1

NATIONAL FOREWORD

This Indian Standard (Third Revision) which is identical with ISO 31-1 : 1992 'Quantities and units — Part 1 : Space and time' issued by the International Organization for Standardization (ISO), was adopted by the Bureau of Indian Standards on the recommendation of the Basic Standards Sectional Committee (MSD 1) and approval of the Management and Systems Division Council.

The text of the ISO Standard has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Comma (,) has been used as a decimal marker while in Indian Standards the current practice is to use a point (.) as the decimal marker.

b) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

This standard was first published in 1961 and then revised in 1967 and 1982 respectively.

In this third revision, the following changes have been made:

a) The decision by International Committee for Weights and Measures (CIPM) in 1980 concerning the status of supplementary units has been incorporated.

b) Units in use temporarily have been transferred to the column 'Conversion Factors and Remarks'.

c) The special remark on logarithmic quantities and units has been elaborated.

In the adopted standard, normative references appear to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 31-0 : 1992	IS 1890 (Part 0) : 1994 Quantities and units: Part 0 General principles (*first revision*)	Identical

In the adopted standard, normative reference has also been made to ISO 8601 : 1988 'Data elements and interchange formats information interchange — Representation of dates and times', for which no Indian Standard exists. The concerned Sectional Committee has reviewed the provisions of this International Standard and has decided that it is acceptable for use in conjunction with this standard.

ADDITIONAL INFORMATION

IS 1890/ISO 31 consists of the following parts, under the general title 'quantities and units' :

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 31-1 : 1992	IS 1890 (Part 1):1995 Quantities and units: Part 1 Space and time (*third revision*)	Identical
ISO 31-2 : 1992	IS 1890 (Part 2) : 1995 Quantities and units: Part 2 Periodic and related phenomena (*second revision*)	Identical

(Continued on fourth cover)

AMENDMENT NO. 1 FEBRUARY 1997
TO
IS 1890 (PART 1) : 1995/ISO 31-1 : 1992
QUANTITIES AND UNITS
PART 1 SPACE AND TIME

(Third Revision)

(*Second cover page, National Foreword, last second para above Additional Information*) — In the second column substitute 'IS 1890 (Part 0) : 1995' *for* 'IS 1890 (Part 0) : 1994'.

(*Second cover page, National Foreword, last line, matter appearing in brace*) — Substitute '*third*' *for* '*fourth*'.

(*Third cover page, National Foreword, second entry from top*) — Substitute the following for the existing matter:

ISO 31-4 : 1992	*IS 1890 (Part 4):1982/ISO 31/4-1978 Quantities, units and symbols : Part 4 Heat (*first revision*)	Technically Equivalent

(*Third cover page, National Foreword, fourth entry from top*) — Substitute the following for the existing matter:

ISO 31-6 : 1992	†IS 1890 (Part 6) Quantities and units : Part 6 Light and related electromagnetic radiations (*first revision*)	Identical

(*Third cover page, National Foreword, last entry*) — Substitute the following for the existing matter:

ISO 31-13 : 1992	†IS 1890 (Part 13) Quantities and units : Part 13 Solid state physics (*first revision*)	Identical

(*Third cover page, National Foreword*) — Insert the following at the end:

'*Under revision.

†Under print.'

(MSD 1)

Reprography Unit, BIS, New Delhi, India

Indian Standard

QUANTITIES AND UNITS

PART 1 SPACE AND TIME

(Third Revision)

1 Scope

This part of ISO 31 gives names and symbols for quantities and units of space and time. Where appropriate, conversion factors are also given.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 31. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this part of ISO 31 are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 8601:1988, *Data elements and interchange formats — Information interchange — Representation of dates and times.*

3 Names and symbols

The names and symbols for quantities and units of space and time are given on the following pages.

SPACE AND TIME **Quantities**

Item No.	Quantity	Symbol	Definition	Remarks
1-1	angle, (plane angle)	$\alpha, \beta, \gamma, \vartheta, \varphi$	The angle between two half-lines terminating at the same point is defined as the ratio of the length of the included arc of the circle (with its centre at that point) to the radius of that circle	Other symbols are also used.
1-2	solid angle	Ω	The solid angle of a cone is defined as the ratio of the area cut out on a spherical surface (with its centre at the apex of that cone) to the square of the radius of the sphere	
1-3.1	length	l, L		Length is one of the base quantities on which the SI is based.
1-3.2	breadth	b		
1-3.3	height	h		
1-3.4	thickness	d, δ		
1-3.5	radius	r, R		
1-3.6	diameter	d, D		
1-3.7	length of path	s		
1-3.8 (—)	distance	d, r		
1-3.9 (—)	cartesian coordinates	x, y, z		
1-3.10 (—)	radius of curvature	ϱ		

Units				SPACE AND TIME
Item No.	**Name of unit**	**International symbol for unit**	**Definition**	**Conversion factors and remarks**
1-1.a	radian	rad	1 rad = 1 m/m = 1	See the introduction, subclause 0.3.2. The radian is the angle between two radii of a circle which cut off on the circumference an arc equal in length to the radius.
1-1.b	degree	°	$1° = \frac{\pi}{180}$ rad	1° = 0,017 453 3 rad There shall be no space between a numerical value and any of these superscript-type unit symbols. The degree should preferably be subdivided decimally. The unit symbol shall then be placed after the number. EXAMPLE Write 17,25° rather than 17°15′.
1-1.c	minute	′	1′ = (1/60)°	
1-1.d	second	″	1″ = (1/60)′	
1-2.a	steradian	sr	1 sr = 1 m^2/m^2 = 1	See the introduction, subclause 0.3.2. The steradian is the solid angle of a cone which, having its vertex in the centre of a sphere, cuts off on the surface of the sphere an area equal to that of a square with sides of length equal to the radius of the sphere.
1-3.a	metre	m	The metre is the length of the path travelled by light in vacuum during a time interval of 1/299 792 458 of a second	ångström (Å), 1 Å = 10^{-10} m (exactly) nautical mile, 1 nautical mile = 1 852 m (exactly) This definition was adopted by the First International Extraordinary Hydrographic Conference, in 1929.

SPACE AND TIME (*continued*) Quantities

Item No.	Quantity	Symbol	Definition	Remarks
1-4 (—)	curvature	$\varkappa$	$\varkappa = 1/\varrho$	
1-5 (*1-4.1*)	area	A, (S)	$A = \iint \mathrm{d}x\,\mathrm{d}y$ where x and y are cartesian coordinates	For an element of area, $\mathrm{d}\sigma$ is sometimes used.
1-6 (*1-5.1*)	volume	V	$V = \iiint \mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z$ where x, y and z are cartesian coordinates	For an element of volume, $\mathrm{d}\tau$ is sometimes used.
1-7 (*1-6.1*)	time, time interval, duration	t		Time is one of the base quantities on which the SI is based.
1-8 (*1-7.1*)	angular velocity	ω	$\omega = \frac{\mathrm{d}\varphi}{\mathrm{d}t}$	
1-9 (*1-8.1*)	angular acceleration	α	$\alpha = \frac{\mathrm{d}\omega}{\mathrm{d}t}$	This equation applies to rotation about a fixed axis. It may also be applied generally, provided that both ω and α are regarded as vectors.

Units				SPACE AND TIME (*continued*)
Item No.	**Name of unit**	**International symbol for unit**	**Definition**	**Conversion factors and remarks**
1-4.a	reciprocal metre, metre to the power minus one	m^{-1}		
1-5.a	square metre	m^2		The unit are, symbol a, (and its multiple hectare, symbol ha) are used to express agrarian areas, 1 a = 100 m^2 (exactly).
1-6.a	cubic metre	m^3		
1-6.b	litre	l, L	1 l = 1 dm^3	1 l = 10^{-3} m^3 (exactly) In 1964 the 12th CGPM redefined the litre as 1 l = 1 dm^3. According to the older definition the litre was equal to 1,000 028 dm^3. The two symbols for the litre are on an equal footing. The CGPM will later consider the possibility of retaining only one of the symbols.
1-7.a	second	s	The second is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium-133 atom	
1-7.b	minute	min	1 min = 60 s	For representations of time of day, see ISO 8601.
1-7.c	hour	h	1 h = 60 min = 3 600 s	
1-7.d	day	d	1 d = 24 h = 86 400 s	
1-8.a	radian per second	rad/s		For other units, see 1-1.b...d.
1-9.a	radian per second squared	rad/s^2		For other units, see 1-1.b...d.

SPACE AND TIME (*concluded*) Quantities

Item No.	Quantity	Symbol	Definition	Remarks
1-10 (*1-9.1*)	velocity	v, c, u, v, w	$v = \frac{\mathrm{d}s}{\mathrm{d}t}$	v is the general notation. c is used for speed or velocity of propagation of waves. When vector notation is not used, the notation u, v, w for the components of a velocity c is recommended. In the English language the magnitude of velocity is usually called speed. In the French language the term "celérité" is used for speed or velocity of propagation of waves.
1-11.1 (*1-10.1*)	acceleration	a	$a = \frac{\mathrm{d}v}{\mathrm{d}t}$	This equation applies to rectilinear motion. It also applies generally if a and v are vectors.
1-11.2 (*1-10.2*)	acceleration of free fall, acceleration due to gravity	g		Standard acceleration of free fall: $g_n = 9{,}806\ 65\ \mathrm{m/s^2}$ (exactly) (3rd CGPM, 1901)

Units				SPACE AND TIME (*concluded*)
Item No.	**Name of unit**	**International symbol for unit**	**Definition**	**Conversion factors and remarks**
1-10.a	metre per second	m/s		
1-10.b	kilometre per hour	km/h		1 km/h = $\frac{1}{3,6}$ m/s (exactly) = 0,277 778 m/s knot (kn), 1 kn = 1 nautical mile per hour = 0,514 444 m/s
1-11.a	metre per second squared	m/s^2		

Annex A
(informative)

Units based on the foot, pound and second and some other units

The use of these units is deprecated.

Quantity Item No.	**Quantity**	**Unit Item No.**	**Name of unit with symbol**	**Conversion factors and remarks**
1-3.1	length	1-3.A.a	inch: in	1 in = 25,4 mm (exactly) The "mil" or "thou" is sometimes used to denote the "milli-inch".
		1-3.A.b	foot: ft	1 ft = 12 in (exactly) = 0,304 8 m (exactly) The U.S. Survey foot, used by the U.S. Coast and Geodetic Survey, is defined as 1 U.S. Survey foot = $\frac{1\,200}{3\,937}$ m = 1,000 002 × 0,304 8 m = 0,304 800 6 m
		1-3.A.c	yard: yd	1 yd = 3 ft (exactly) = 36 in (exactly) = 0,914 4 m (exactly) This definition was adopted legally by the United States in 1959 (Announcement U.S. Dept. of Commerce, National Bureau of Standards, F.R. Doc. 59-5442 d.d. June 30, 1959) and by the United Kingdom in 1963 (Weights and Measures Act, 1963). An exception is made for the U.S. Survey foot — see the remark to 1-3.A.b.
		1-3.A.d	mile	1 mile = 5 280 ft (exactly) = 1 609,344 m (exactly) The mile of 5 280 ft is also known as the statute mile. 1 U.S. Survey mile = 1 609,347 m
1-5	area	1-5.A.a	square inch: in^2	1 in^2 = 645,16 mm^2 (exactly) The "circular mil" is sometimes used to designate an area of $\frac{\pi}{4} \times 10^{-6}\ \mathrm{in}^2 = 506{,}707\ 5\ \mu\mathrm{m}^2$
		1-5.A.b	square foot: ft^2	1 ft^2 = 0,092 903 04 m^2 (exactly)
		1-5.A.c	square yard: yd^2	1 yd^2 = 0,836 127 36 m^2 (exactly) The abbreviations sq in, sq ft and sq yd are commonly used.
		1-5.A.d	square mile: mile^2	1 mile^2 = 2,589 988 km^2 1 U.S. Survey mile^2 = 2,589 998 km^2 1 mile^2 = 640 acres (exactly)
		1-5.A.e	acre	1 acre = 4 046,856 m^2 1 U.S. Survey acre = 4 046,873 m^2 1 acre = 4 840 yd^2 (exactly)

Units based on the foot, pound and second and some other units *(continued)*

Quantity Item No.	Quantity	Unit Item No.	Name of unit with symbol	Conversion factors and remarks
1-6	volume	1-6.A.a	cubic inch: in^3	1 in^3 = 16,387 064 cm^3 (exactly)
		1-6.A.b	cubic foot: ft^3	1 ft^3 = 28,316 85 dm^3 (exactly)
		1-6.A.c	cubic yard: yd^3	1 yd^3 = 0,764 554 9 m^3 The abbreviations cu in, cu ft and cu yd are commonly used.
		1-6.A.d	gallon (UK): gal (UK)	1 gal (UK) = 277,420 in^3 = 4,546 092 dm^3 (exactly) = 1,200 95 gal (US)
		1-6.A.e	pint (UK): pt (UK)	8 pt (UK) = 1 gal (UK) 1 pt (UK) = 0,568 261 25 dm^3 (exactly) = 1,200 95 liq pt (US)
		1-6.A.f	fluid ounce (UK): fl oz (UK)	160 fl oz (UK) = 1 gal (UK) 1 fl oz (UK) = 28,413 06 cm^3 = 0,960 760 fl oz (US)
		1-6.A.g	bushel (UK)	1 bushel (UK) = 8 gal (UK) = 36,368 72 dm^3 (exactly) = 1,032 06 bu (US)
		1-6.A.h	gallon (US): gal (US)	1 gal (US) = 231 in^3 = 3,785 412 dm^3 = 0,832 674 gal (UK)
		1-6.A.i	liquid pint (US): liq pt (US)	8 liq pt (US) = 1 gal (US) 1 liq pt (US) = 0,473 176 5 dm^3 = 0,832 674 pt (UK)
		1-6.A.j	fluid ounce (US): fl oz (US)	128 fl oz (US) = 1 gal (US) 1 fl oz (US) = 29,573 53 cm^3 = 1,040 84 fl oz (UK)
		1-6.A.k	barrel (US) for petroleum, etc.	1 barrel (US) (petroleum) = 9 702 in^3 = 158,987 3 dm^3 = 34,972 3 gal (UK) = 42 gal (US)
		1-6.A.l	bushel (US): bu (US)	1 bu (US) = 2 150,42 in^3 = 35,239 07 dm^3 = 0,968 939 bushel (UK)
		1-6.A.m	dry pint (US): dry pt (US)	64 dry pt (US) = 1 bu (US) 1 dry pt (US) = 0,550 610 5 dm^3 = 0,968 939 pt (UK)
		1-6.A.n	dry barrel (US): bbl (US)	1 bbl (US) (dry) = 7 056 in^3 = 115,627 1 dm^3

Units based on the foot, pound and second and some other units (*concluded*)				
Quantity Item No.	**Quantity**	**Unit Item No.**	**Name of unit with symbol**	**Conversion factors and remarks**
1-10	velocity	1-10.A.a	foot per second: ft/s	1 ft/s = 0,304 8 m/s (exactly)
		1-10.A.b	mile per hour: mile/h	1 mile/h = 0,447 04 m/s (exactly)
1-11.1	acceleration	1-11.A.a	foot per second squared: ft/s^2	1 ft/s^2 = 0,304 8 m/s^2 (exactly)

Annex B
(informative)

Other non-SI units given for information, especially regarding the conversion factor

Quantity item No.	Quantity	Unit item No.	Name of unit with symbol	Conversion factors and remarks
1-1	angle, (plane angle)	1-1.B.a	gon (or grade): gon	1 gon = $\frac{\pi}{200}$ rad = 0,015 707 96 rad
1-3.1	length	1-3.B.a	light year: (l.y.)[1]	1 light year is the distance travelled in 1 year by electromagnetic waves in free space. 1 l.y. = $9{,}460\ 730 \times 10^{15}$ m
		1-3.B.b	astronomical unit: (AU)[2]	1 AU = $1{,}495\ 978\ 7 \times 10^{11}$ m (adopted value in System of Astronomic Constants, 1976)
		1-3.B.c	parsec: pc	1 parsec is the distance at which 1 astronomical unit subtends an angle of 1 second of arc. 1 pc = 206 264,8 AU = $30{,}856\ 78 \times 10^{15}$ m
1-7	time	1-7.B.a	year, tropical year: a, a_{trop}	The tropical year is the time which elapses between two successive passages of the sun through the mean vernal equinox. This time interval is related to the corresponding difference of mean longitude of the sun, which depends on time in a not exactly linear form; i.e. a_{trop} is not constant but decreases at a rate of nearly 0,53 s per century. The tropical year is approximately equal to 365,242 20 d = 31 556 926 s.
1-11.2	acceleration of free fall	1-11.B.a	gal: Gal	1 Gal = 0,01 m/s^2 (exactly) The milligal is commonly used in geodesy.

1) "l.y." is an abbreviation for the name light year.

2) "AU" is an abbreviation for the name astronomical unit.

NOTES

(*Continued from second cover*)

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 31-3 : 1992	IS 1890 (Part 3) : 1995 Quantities and units: Part 3 Mechanics (*second revision*)	Identical
ISO 31-4 : 1992	IS 1890 (Part 4) : 1995 Quantities and units : Part 4 Heat (*second revision*)	Technically Equivalent
ISO 31-5 : 1992	IS 1890 (Part 5) : 1995 Quantities and units: Part 5 Electricity and magnetism (*first revision*)	Identical
ISO 31-6 : 1992	IS 1890 (Part 6) : 1995 Quantities and units : Part 6 Light and related electromagnetic radiations (*first revision*)	Technically Equivalent
ISO 31-7 : 1992	IS 1890 (Part 7) : 1995 Quantities and units: Part 7 Acoustics (*first revision*)	Identical
ISO 31-8 : 1992	IS 1890 (Part 8) : 1995 Quantities and units: Part 8 Physical chemistry and molecular physics (*first revision*)	Identical
ISO 31-9 : 1992	IS 1890 (Part 9) : 1995 Quantities and units: Part 9 Atomic and nuclear physics (*first revision*)	Identical
ISO 31-10 : 1992	IS 1890 (Part 10) : 1995 Quantities and units: Part 10 Nuclear reactions and ionizing radiation (*first revision*)	Identical
ISO 31-11 : 1992	IS 1890 (Part 11) : 1995 Quantities and units: Part 11 Mathematical signs and symbols for use in the physical science and technology (*second revision*)	Identical
ISO 31-12 : 1992	IS 1890 (Part 12) : 1995 Quantities and units: Part 12 Characteristic numbers (*first revision*)	Identical
ISO 31-13 : 1992	IS 1890 (Part 13) : 1995 Quantities and units : Part 13 Solid state physics (*first revision*)	Technically Equivalent

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